

**INTERNATIONAL JOURNAL OF
INNOVATIVE RESEARCH AND KNOWLEDGE**

ISSN-2213-1356

www.ijirk.com

**The Challenges and Opportunities in Using ICTs in
Disseminating Climate Change Information in Rural Areas:
The Case of Mobile Phones¹**

**Jasson Kalugendo²
&
Nyendo Absalom Kinyonga³**

Abstract

The purpose of this study was to assess the challenges and opportunity of using mobile phones in disseminating climate change information to improve knowledge and increase climate change adaptation in rural communities. The study employed techniques from both qualitative and quantitative approaches to collect data from among 100 respondents. The study found that mobile phones have transformed how rural people interact and make communication an essential part of people living in rural areas. It is feasible that mobile phones can enhance

¹The authors wish to acknowledge the support of the Centre for Climate Change Studies (CCCS), University of Dar Es Salaam provided throughout the study.

² Jasson Kalugendo holds a Doctoral Philosophy degree (focusing on social capital) and a MA (corporate communications) and BA (social communications). He is International Knowledge Management, Communication and Capacity Development expert with global experience across a broad range of thematic areas including church leadership, forest management, climate change communication, policies for inclusive development, social business, knowledge management, capacity development, communication for development and strategic planning. He has written several articles and reports on communication for development, environment communication, corporate communication, development effectiveness, capacity development and the importance of critical knowledge for national development. He regularly lectures at the University of Dar es Salaam and the Center for Climate Change and is a research associate in the Department of Dogmatics and Christian Ethics of the University of Pretoria, South Africa.

³ Nyendo Absalom kinyonga hold MSc. Degree in Climate Change and Sustainable Development from Centre for Climate Change Studies (CCCS), University of Dar es salaam-Tanzania, East Africa

access and flow of information related to climate change mitigation and adaptation in the rural communities. On the other hand, the study found that the application of mobile phones in climate change mitigation and adaptation still limited due to insufficient technological capacity to utilize fully the potential of mobile technology, socio-economic structures, unreliable physical infrastructure and cultural norms. Therefore, the better use of mobile phones in rural areas requires a joint venture between the mobile providers, government, Non-Governmental Organizations (NGOs) and community. The results call for a larger-scale research to generate empirical data for full integration of mobile phones into rural socio-economic development.

Key words: *Climate change, Mobile phone, Communication, Adaptation, Rural Development*

Introduction

Climate change is a *de facto* threat to socio-economic development; hence it has dominated the global agenda in this decade Intergovernmental Panel on Climate Change [IPCC], 2007; Lahonzio, 2013; United National Development Programme [UNDP], 2012. The International community has developed financial resources and technical assistance to sectors such as forest, energy and agriculture (Pandve, 2008; IPCC, 2007; UNDP, 2012). Most countries including those in Sub-Saharan Africa have mainstreamed climate change issues into budgeting and planning policies to intensify the implementation of its mitigation, resilience and adaptation options at both national and sub-national levels (Yandaet al., 2013; United Republic of Tanzania [URT], 2007; *Inter Press Service*, 2014). Regardless of notable efforts made to cope with adverse impacts, there are setbacks to reach the intended objectives regarding climate change adaptation, particularly in developing countries. For example, most countries in Africa, by and large, rely on foreign funds to implement national strategies relating to climate change. Other challenges include poverty, policy mismatch, civil conflicts, ineffective cooperation and uncoordinated strategies (UNDP, 2012; URT, 2007; Kalugendo and MacLeod, 2013). Furthermore, rural audiences still have limited access to communication conduits such as television, radio and newspapers (Boulahyaet al., 2005; Harvey et al., 2012; Hassan and Semkwiji, 2011). In areas where radio and mobile phones are available, inadequate technical know-how restricts the utilization of such technology to disseminate information on climate change Advancing Capacity to Support Climate Change [ACSCC], 2009; Moser and Dilling, 2011).

There also are empirical agreements (IPCC, 2007; URT, 2007) that the rural communities are the most vulnerable to climate change effects, climate change adaptation has not yet been institutionalized per se, at the low level of the government. Several studies have pointed out major obstacles facing climate change adaptation in rural areas. These include insufficient communication structure, incompatible technology and unreliable information (Boulahyaet al., 2005; Harvey et al., 2012; Hassan and Semkwiji, 2011).

Problem Statement

In the recent years, mobile phone has been acknowledged as a “tech solution” for rural socio-economic development (World Bank, 2012). The influx of mobile phones has improved the connectivity between urban and rural communities (Business and Economics, 2007). Other studies have indicated that Information and Communication Technologies (ICTs) in general are an upper-hand in disseminating climate information products (Mendis et al., 2003; IPCC, 2007; CSDI, 2011).

Therefore, major concern for this study is what are the challenges and opportunities facing the application of mobile phone in disseminating climate change related information in rural areas?

Theoretical Framework for Mobile Application in the rural Areas

The theory of technological determinism (TD), postulates that technology is the force that shapes societal development (Fiore and Angel, 1967; Adler, 2006). Originally, the theory claims that technology is quasi-magic power, works autonomously and is an indispensable force behind any major societal change (McLuhan, 1964). In addition, Mackenzie and Wajcman (1999) argue that human life is intertwined with technology no matter how simple or sophisticated technology is. Cutcliffe (2000) believes that technology changes the way people live, work, interact, communicate and solve their daily problems.

In the new technological determinism is labelled as social shaping technology (Salazar-Acosta and Holbrook, 2008). Klein and Kleinman, 2002; Pinch and Bijke, 1989) have opened the black box of the TD and argued that technology is a dimension of society and shaped by social factors. Salazar-Acosta and Holbrook (2008) posit that TD deducts the social development into a single solution and carries a one-dimensional effect and undermines the influence of society on technology. Cutcliffe (2000) suggests that technology is constructed, interpreted and modified within socio-economic, political and cultural structures. He further argues that Technology is a man-made artefact designed to open alternative solutions to social problems and is subject to societal influence (Salazar-Acosta and Holbrook, 2008). Bijker (2001) and Cutcliffe (2000) argue that success and failure in any technology is determined by social systems. This implies that technology is meaningful when people have willingness, ability and the knowledge to apply it. End-users may define what technology is for and deviate from its original intent (Bijker, 2001).

The work of Mackenzie and Wajcman (1999) and Marx and Smith (1994) equate the social constructivism and technological determinism theories. Mackenzie and Wajcman 1999 argue that, although the effect of technology is contingent upon social, cultural, political and human facets, technology still has a direct effect on society. Marx and Smith (1994) consider the impact of technology from both a hard and soft perspective. In “hard effect” effective perspective, technology is a changing agent whereas from a soft effect point of view technology gets meaning within social, economic and cultural realms. Hence, technological and societal artefacts depend on and influence each other (Salazar-Acosta and Holbrook, 2008).

Research Design

The study was, by and large, a qualitative study and has employed a wide variety of research methods and approaches to obtain in-depth accounts of opportunity and challenges of mobile phones and gain knowledge on complexity of socio-economic and cultural artefacts and realities in rural areas where mobile phones are operated (Staller, 2010). Also, the study triangulated data collection and analysis techniques of both qualitative and quantitative paradigms. Gough (2012) and Cresswell (2009) pointed out that triangulation methods dominated social research design as it was impossible for one study to learn only on either a qualitative or quantitative method. This was true on this study. The design of the study borrowed much qualitative paradigm and was prominently concerned with exploration.

It is important, however, to emphasize here that the results of this study were processed based on grounded theory. This implies that data was systematically collected, analysed and interpreted from the perspectives of participants. Prior categories and questions posed at the beginning of the study were confirmed, unconfirmed or enriched by the data (Milliken, 2010).

Site Selection, Population and Sampling Procedure

The study employed “purposive” sampling (a non-probability procedure) to select geographical areas and participants for the study. This sampling procedure is applied because the study is examining the participants who

have experience and knowledge on mobile phone uses in the rural setting (Creswell, 2009). Based on this sampling method, the criteria of inclusion and exclusion of participants was established. The selection of participants was based on their past experiences in using a mobile phone, willingness to participate in the research and capacity to provide relevant and in-depth information (Oliver, 2000).

The study assessed the challenges and opportunity of using mobile phones to support the dissemination of climate change information to enhance the capacity of communities 'adaptation. Kiteto was selected on the basis that it was one of the districts that had recently experienced the worst impact of climate change in Manyara Region (URT, 2007; Thornton *et al.*, 2002). Consequently, it was assumed that the community in this area had a better understanding of the importance that information could help them address climate change effects. Because mobile phones are becoming commonplace amongst rural dwellers, it was expected that the study would extract useful and relevant in-depth information on how villagers come upon the challenges and opportunities of mobile phones.

Povall's (2006) ethnographic approach underlines the importance of gathering data on the implementation or function of innovation from the same selected participants in a single community but tests the hypothesis through using different tools among the same group of people. Using this approach, the study utilized different methods to obtain holistic picture from the same participants, specifically on conditions that may positively and negatively affect the use of mobile phones in the community.

Instruments of Data Collection

The study utilized different techniques such as think-aloud and interviews and questionnaires to obtain information from the same group or participants. One of the advantages of obtaining information from multiple tools is that repetition of usage and responses increases the validity of the data (Creswell, 2009; Troman *et al.*, 2006).

Participants were asked to give accounts from their real life experience on constraints or breakthroughs in each provided case (Taylor and Dione, 2000). These cases were categorized in four types namely accessibility, affordability, compatibility and knowledge.

Using the conventional basis proposed by Ericsson and Simon (1993), the study organized the think-aloud sessions as follows: Firstly, everybody participated in a brief training session. During this session, the researcher established a rapport with the informants and helped them to familiarize themselves with the topic and procedures. Secondly, the researcher presented short written descriptions of each case and read them aloud to the participants. Thirdly, participants were given ten minutes to think about each scenario before the discussion begun. Next, for some two hours, participants discussed aloud the challenges, opportunities and solutions in each case.

Data from interviews and descriptions of cases was subject to content and interpretive analysis. Data from the surveys was analyzed through descriptive statistics and presented in the figures and tables. The responses from think-aloud sessions were analyzed under four main areas: accessibility, affordability, compatibility and knowledge.

Results and Discussion on the Key Findings

This part summarizes the findings and discussion obtained from the field within the study area regarding general ideas on the household mobile ownership and challenges vis-a-vis opportunity of using mobile phones in the study area.

Mobile phone ownership per households

The study found that people within the household owned a mobile phone to communicate easily with their friends and family. When respondents were asked for the reasons or factors that led to them buying a mobile phone, it was

discovered that the primary reason was to communicate with their families and friends. The study reveals that almost all respondents (95%) used their mobile phone to network with friends and relatives, whereas a very small number (5%) used a phone for business or work related purposes. When the respondents were asked about the number of mobile phones they owned within the household, a majority of households said they had one or two mobile phones, though a few had more than two mobile phones. This implies there is an opportunity to use the mobile phones for a household to get information about climate change adaptation.

This finding agrees with two other studies sponsored by the World Bank (2012) and InterMedia (2013) in Tanzania. Both studies revealed that the primary reason for using a mobile phone by rural users in Tanzania was calling and text messaging, whereas money transactions, 'googling', 'selfies' were less common in the areas.

This implies that rural people are interested in communicating and not searching for information. Thus, using mobile phones to support climate change adaptation and mitigation will not encourage local people to access websites to seek out such information in this way. Rather, such information should carry a story of 'human interest' so individuals in the family will convey this information within their circle of friends and relatives. Adler (2006) emphasized that technology was not static. Rural people need to understand about technological changes associated with mobile phones and develop this knowledge so that they maximize the potential of mobile phone use.

When asked if they ever changed their mobile phones, 50% of respondents stated that they had changed once or replaced the phone if it were lost or not working. They also changed the phone to get additional services or a better network. Another 50% of respondents indicated that they had not changed their phone. This was because either their phones were functioning well or they could not afford to purchase another more expensive one.

Almost all the respondents in this study indicated the major reason to buy mobile phones was to constantly and efficiently communicate with their friends and relatives. More than two-thirds of the household's had more than one mobile phones and most of these phones could only either send a message or make a call.

The study established that limited purchasing power or insufficient knowledge to operate the most advanced mobile phones were not the main factors that caused respondents to buy basic mobile phones. The main reason for buying basic phones was to call or send text messages. Respondents would keep these basic mobile phones as long as they were able to send text messages and call people within their social networks. This finding agrees with two other studies sponsored by the World Bank (2012) and InterMedia (2013) in Tanzania. Both studies revealed that the primary reason for using a mobile phone by rural users in Tanzania was calling and text messaging, whereas money transactions, 'googling', 'selfies' were less common in the areas.

This implies that rural people are interested in communicating and not searching for information. Thus, using mobile phones to support climate change adaptation and mitigation will not encourage local people to access websites to seek out such information in this way. Rather, such information should carry a story of 'human interest' so individuals in the family will convey this information within their circle of friends and relatives.

Respondents were asked specifically how they normally used their mobile phones. Figure 3 indicates that almost all the respondents used the phone to make calls. Other notable usage included: text messages (52%), money transactions (sending and receiving money) (35%) and general banking (35%).

From the above data, there is sufficient evidence that mobile phones are primarily used to communicate amongst friends and relatives. They are also regarded as private property and enhanced communication as an indispensable part of life. There is also evidence that when information will be disseminated through mobile phones people at household level will receive information in time. More than two-thirds of the households had more than one mobile phones and most of these phones could only either send a message or make a call. This implies that rural people are

interested in communicating and not searching for information. Thus, using mobile phones to support climate change adaptation and mitigation will not encourage local people to access websites to seek out such information in this way. Rather, such information should carry a story of 'human interest' so individuals in the family will convey this information within their circle of friends and relatives.

The study confirms with theoretical assumption drawn from literature that the application of mobile phones is determined by the reality of socio-economic and cultural structures. In this study respondents revealed that their education level was a hindrance to full usage of mobile phone applications. Respondents preferred calling to texting messages because the majority could not read or write. The language built into the phone was not user-friendly because users could not read, understand or use troubleshoot applications to solve problems. Thus, any content that was presented in any language other than Kiswahili limited the use of mobile phones by people in rural areas. This finding concurs with the study conducted by Donohue and Ohen (1986) that education levels of the users could be enabling or a hindrance in adapting to changes in technology.

Challenges and Opportunities of Using Mobile Phones

Four categories including accessibility, affordability, compatibility and knowledge were identified from the literature as possible factors that influence effectiveness or ineffectiveness of mobile phone applications in rural areas. The data from think-aloud discussions confirmed that these four categories are challenges or opportunities of utilizing mobile phones in rural areas.

Accessibility

Access to network services is one of the factors that respondents refer to as an obstacle to engage people in socio-economic and environmental issues. It was noted in the study that most of the respondents use Airtel (85%), followed by Vodacom (25%). Tigo were used least (4%). It may be that this data suggests Airtel is the dominant provider in rural areas, even from this small sample, as it appears access to their services may well be better than the others.

Nonetheless, the respondents indicated that none of the mobile phone providers has a stable network signal or office to support the people. The signal across all mobile providers fluctuates and no agent provides customer support to users in rural areas. So, users switch from one provider to another, depending on which network is available. The following excerpt illustrates this:

None of the major mobile providers has a constant network signal or an agent office to answer users' questions. We rely on retailers who normally sell pre-paid airtime vouchers.

The study confirms with theoretical assumption drawn from literature that the application of mobile phones is determined by technology, Poor infrastructure impedes the use of mobile phones. For example, the absence of power makes it almost impossible to charge the phone locally. In this study, charging the phones added to operational costs and there was a vacuum of communication when the phones were being charged. The study further revealed that unreliable and poor signal reception affected the quality of services the users received from the mobile phone providers. This finding is supported by Heeks and Kanashiro (2009) who argued that insufficient physical infrastructure such as electricity impeded the effectiveness of ICT to promote development in rural areas.

Affordability

As noted before, respondents purchase a mobile phone that provides basic functions (calling and text message) primarily because of income limitations. Although they ensure that the phones have airtime and are functioning, at times it is hard for individuals to buy additional airtime. One of the respondents said:

People living in this community rely heavily on agricultural products for food and income. When the market for agricultural produce is low, mobile phone users face a choice of either buying basic needs for the family or airtime for the phones.

Compatibility

Respondents discussed whether or not mobile phone technology was in line with their culture. The people in the community inherited a male-dominant system where a man determines every conversation; even deciding which family members should or should not talk. To the contrary, mobile phone usage enables communication between family members. One male respondent said:

“In the family where a couple owns two different mobile phones, they are always suspicious of each to the extent that either the wife or husband secretly searches the partner’s phone to find out what kind of messages are being received or sent, who are the most communicated to and whose numbers are stored in the phone.”

Likewise, a female respondent said that in the family where they own one mobile phone “... *Couples quarrels with each other over the phone because neither husband nor wife has a right to occupy a phone longer than usual....*” Either situation causes misunderstanding or mistrust and ultimately could lead to domestic quarrels and violence. In addition, the makeup of the mobile phone requires a constant power source that is not always available in rural areas. Respondents stated that most families did not have access to electricity or solar energy and charging needed to be done regularly. The availability and cost of power to charge mobile phones in rural areas was a concern of many people. For example, respondents during the FGDs had this to say:

“Charging a phone is a headache as people must travel quite a distance to charge their phones. This is also expensive because there is a payment for the power necessary to charge the phone and it can also take a whole day, during which time the user cannot make or receive calls”.

It’s clear stated by the theory of social constructivism on how social, culture, political and economic can affects or influence on the use of technology (Cutcliffe,2009) as have been revealed also on the study., therefore technology and societal depends each other.

The mobile phone can be a powerful cultural tool in a male dominant society. In unpacking the responses from interviews in this study, it was evident that male and female respondents agreed that women had a limited access to mobile phones compared to man in rural areas. To be effective, mobile phone technology needed to access the compatibility of cultures where phones were in use (Ospina and Heeks, 2011). Also, education on the right ‘to know and access information’ was needed in order to change cultural habits that currently inhibit mobile phone usage and development in rural areas.

This study has established that no single agent can claim full effectiveness of mobile phone applications in rural areas. Thus, partnership among operators is key in making mobile applications effective. In recognizing the seriousness of climate change, Fry (2003) suggests that mobile phone providers could be drawn to support the infrastructure in rural areas. For example, partnerships could be forged to ensure each village has an agent who has the facility to change the phone and provide basic services to restore or bring the phones back to full operation. Such providers could work with banks or microfinance groups in rural communities to provide credits for small-scale and affordable solar energy panels to increase the ability to charge mobile phones locally.

Knowledge

The respondents highlighted several ways how knowledge limited the use of mobile phones amongst users living in rural areas. The standard of education of users was often mentioned as a barrier to understanding the language and operation of mobile phones. Users had difficulty in reading the instructions on how to operate some of the applications or maintain the phone. Kiswahili, which is the common language of most users, was not a part of mobile phone system language or in the User manual. As one of the respondents stated:

“Absence of a skilled technician to repair our phones or troubleshoot the system inhibits the potential of mobile phones in our areas. I prefer calling my relatives and friends to text messaging because most of them cannot either read or send the text message.”

The study confirms with theoretical assumption drawn from literature that the application of mobile phones is determined by the reality of socio-economic and cultural structures. In this study respondents revealed that their education level was a hindrance to full usage of mobile phone applications. Respondents preferred calling to texting messages because the majority could not read or write. The language built into the phone was not user-friendly because users could not read, understand or use troubleshoot applications to solve problems. Thus, any content that was presented in any language other than Kiswahili limited the use of mobile phones by people in rural areas. This finding concurs with the study conducted by Donohue and Ohen (1986) that education levels of the users could be enabling or a hindrance in adapting to changes in technology. This implies that technology is meaningful when people have willingness, ability and the knowledge to apply it. End-users may define what technology is for and deviate from its original intent (Bijker, 2001).

Summary and Conclusions

The result of this study indicates that mobile phones have revolutionized how rural people interact and have made communication an essential part of people's lives in rural areas. It is feasible that people in such areas can receive and send climate change mitigation and adaptation information through a mobile phone.

The effectiveness of this, however, requires integrated interpersonal communication, linkage of existing and new knowledge, capacity building of users, assessment of what people know, think and believe in a wide spectrum of issues related to climate and making that information relevant to the intended audience. It is time for government, private companies and Non-Government Organizations (NGOs) in Tanzania to realize the potential of mobile technology in addressing today's most burning national challenges in improving the climate change resilience and livelihood of the rural communities. Innovation is needed to unlock the potential of this technology to disseminate the climate change adaptation information. This calls for a larger-scale research to generate empirical data for full integration of mobile phones into rural socio-economic development.

REFERENCE

- Adler, P. S. (2006). Technological determinism, in *The International Encyclopedia of Organization Studies*, edited by Stewart Clegg, S., and James, R. Bailey. California: SAGE Publication.
- Advancing Capacity to Support Climate Change (ACSCC), (2009). Communicating Climate Risks retrieval from <http://www.start.org/download/publications/accca09-web.pdf>
- Bijker, W. E. (2001). Understanding technological culture through a constructivist view of science, technology and society. In C. Mitcham (Ed.), *Visions of STS: Counterpoints in Science, Technology, and Society Studies* (pp. 19-34). Albany: State University of New York Press.
- Boulahya, M., Cerda, S. M., Pratt, M. and Sponberg, K. (2005). Climate, communications, and innovative technologies: Potential impacts and sustainability of New Radio and Internet linkages in rural African communities, in *Climatic Change*, 70: 299–310.
- Business and Economics*. (2007). *Information Economy Report 2007-2008: Science and Technology*, Retrieval from <https://www.books.google.co.tz/books?isbn=9211127246>
- Communication for Sustainable Development Initiatives (CSDI) 2011. The Role of Information and Communication Technologies for Community –Based Adaptation to Climate .Technical Paper
- Creswell, J. W. (2009). *Research Design: Qualitative, quantitative, and mixed methods approach*. Los Angeles: SAGE.
- Cutcliffe, S. (2000). *Ideas, Machines, and Values: An Introduction to Science, Technology, and Society Studies*. Lanham, Md: Rowman and Littlefield Publishers.
- Donohue, G. A., P. J. Tichenor and C. N. Ohen. (1986). “Metro Daily Pullback and Knowledge Gaps, within and between Communities.” *Communication Research*, 13: 453–71.
- Ericsson, K. A., and Simon, H. A. (1993). *Protocol analysis: Verbal reports as data*. Cambridge, MA: MIT Press.
- Fiore, Q, and Angel.J. (1967). *The medium Is the message: An inventory of effects*. New York: Bantam.
- Fry, T. (2003). The private sector and climate change adaptation. *Working Paper* Published by Bretton Woods Project and CAFOD. Retrieved on June 21, 2015 from http://www.brettonwoodsproject.org/wp-content/uploads/2013/12/PPCR_PS_briefing_web.pdf
- Gough, D., Oliver, S., and Thomas, J. (Editors). 2012. *An Introduction to Systematic Reviews*, London: Sage.
- Harvey, B., Carlile, L., Ensor, J., Garside, B., and Patterson, Z. (2012). Understanding context in learning centered approaches to Climate Change Communication, in *IDS Bulletin*, Vol. 43, no. 5: 31-37.
- Hassan, A. K., and Semkwiji, D. (2011). The role of Mobile Phone on Sustainable Livelihood: Economic and Social Research Foundation (ESRF). *Discussion Paper* no.33.
- Heeks, R. and Kanashiro, L. L. (2009). Remoteness, Exclusion and Telecentres in Mountain Regions: Analysing ICT Based "Information Chains" in Pazos, Peru, IDPM Development Informatics Working Paper no.38, University of Manchester, UK <http://www.sed.manchester.ac.uk/idpm/research/publications/wp/di/>

- Inter-media (2013). Mobile money: use, barriers and opportunities. Retrieved from <http://www.intermedia.org/mobile-money-use-barriers-opportunities>
- Inter Press Service. (2014). Policy coherent in tackling climate in Africa. Retrieval from <http://www.ipsnews.net/documents/Policy-coherence-in-tackling-climate-change-in-Africa-fact-sheet.pdf>
- Intergovernmental Panel on Climate Change (IPCC), (2007). Climate Change Impacts, Adaptation and Vulnerability: Summary for Policy Maker.
- Kalugendo, J., and MacLeod, P. (2013). Creating a Participatory Communication Model of Engagement of Local Communities to Enhance Development Effectiveness in Tanzania. *Africa Journal of Communication Vol.1 No.1*.
- Katz, E. (1973). The two-step flow of communication: an up-to-date report of a hypothesis. In *Marketing classics*, Enis and Cox (eds.): Page175-193.
- Klein, H. K., and Kleinman, D. L. (2002). The social construction of technology: Structural considerations. In *Science, Technology and Human Values*, 27(1), 28-52.
- Lahonzio, R. K. (2013). Global Climate Change Initiatives (GCCII). Budget Authority and request, FY2010-FY2014 retrieval from <http://www.fas.org/sgp/crs/misc/R41845.pdf>
- Mackenzie, D., and Wajcman, J. (eds). (1999). *Social shaping technology*. Buckingham: Open University Press.
- Marx, L., and Smith, M. R. (1994). Introduction. In Smith, M. R and Marx, L. (Eds.), *Does Technology Drives History? -The Dilemma of Technological Determinism* (pp. ix-xv). Cambridge (MA), London: MIT Press.
- Mendis, S., Mills, S., and Yantz. (2003). Building community capacity to adapt to climate in resource –Based communities. Retrieval from http://www.climateaccess.org/.../mendis_Building%20Community%20Capacity.p.
- Milliken, P. J. (2010). Grounded theory. In *Encyclopedia of Research Design* (Volume 1) edited by Salkind, N. J. California: SAGE Publications, 548.
- Moser, S. C and Dilling, L. (2011). Communicating Climate Change: Closing the Science-Action Gap in *The Oxford Handbook of Climate Change and Society*. Political Science, Public Policy, Public Administration
- McLuhan, M. (1964). *Understanding Media: The Extensions of Man*. New York: McGraw-Hill
- Oliver, P. (2006). Purposive sampling. Retrieved from: <http://srmo.sagepub.com/view/the-sage-dictionary-of-social-research-methods/n162.xml>.
- Ospina V. and Heeks R. (2011). ICTs and community- based climate change –Nexus for ICTs. Centre for Development Informatics. University of Manchester.
- Pandve, H.T. (2008). *Global Initiatives to prevent climate change .Indian journal of occupational and environmental medicine. August; 12(2):96-97.* Retrieval from [http://www.ncbi.nlm.nih.gov/.../v.12\(2\)](http://www.ncbi.nlm.nih.gov/.../v.12(2)).
- Pinch, T., and Bijker, W. E. (1989). The social construction of facts and artefacts: Or how the sociology of science and sociology of technology might benefit from each other. In W. E. Bijker, W. E., Hughes, T., and Pinch, T. (Eds.), *The social construction of technological systems: New Directions in the Sociology and History of Technology*, Cambridge and London: MIT Press.

- Povall, S. (2006). Policy ethnography: Exploring the local processes of public policy implementation. Retrieved from <http://repository.liv.ac.uk/1278551>.
- Rogers, E. M. (2003). *Diffusion of innovations*. New York: Free Press
- Salazar-Acosta, Mónica and Holbrook, A. (2002). Some notes on theories of technology, society and innovation systems for science and technology policy studies. Retrieved from <http://www.sfu.ca/cprost-old/docs/Monica3a.pdf>.
- Staller, K. M. (2010). Qualitative Research. In *Encyclopedia of Research Design*, Volume 3 edited by Salkind, N. J. (1158). California: SAGE Publications,
- Taylor, K. L., and Dionne, J. P. (2000). Assessing problem- solving strategy knowledge: The complementary use of concurrent verbal protocols and retrospective debriefing. *Journal of Educational Psychology*, 92(3), 413-425.
- Thornton, P. K., Kruska, R. L., Henninger, N., Kristjanson, P. M., Reid R. S., Atieno, F., O dero, A., and Ndegwa, N. (2002), *Mapping poverty and livestock in developing world*. International livestock institute, Nairobi, Kenya.124 pp.
- Troman, G., Jeffrey, B., and Beach, D. (2006). *Researching educational policy: Ethnographic experiences*. London: Trufnell Press. Woodbury, S., and Gess-Newsome, J. (2002).
- United Nation Development Programme (UNDP), (2012). *African human development report: Toward a food secure future*. New York: UNDP.
- United Republic of Tanzania (URT), (2007). *National Adaptation Programme of Action (NAPA)*. Vice President Office, Division of Environment. Dar es Salaam: Tanzania.
- Republic of Tanzania (URT), (2013). *Prime Minister's Office Regional Administration and Local Government. Investment and Socio-Economic Profile Manyara Region*. Regional Commissioner's Office Manyara Region. Dar es Salaam, Tanzania.
- World Bank (2012). Mobile phone access reaches three quarters planets population. Retrieved from <http://www.worldbank.org>.
- Yanda, P., Mushi, D., Henku, A. I., Maganga, F., Minde, H., Malik, N., Kateka, A., Bird, N. and Tilley, H. (2013). *Tanzania national climate change finance analysis: Report*. Overseas Development Institute (ODI).